IMPACT OF ODOUR EMISSIONS ON PUBLIC HEALTH: A REVIEW OF REGULATORY FRAMEWORKS AND EPIDEMIOLOGICAL EVIDENCE IN ITALY

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ABSTRACT

Odorous emissions, primarily originating from industrial activities, livestock farming and waste management facilities, represent an increasing source of environmental disturbance and health concerns for exposed communities. Although odours are often perceived as subjective annoyances, recent scientific evidence suggests a possible association between chronic exposure to odoriferous substances and the onset of respiratory symptoms, sleep disorders, psychological stress and reduced quality of life. This review analyses the epidemiological literature of the last 20 years, assessing the strength of the association between exposure to odorous emissions and health impacts. The results highlight significant methodological gaps, including variability in exposure measurement and a lack of standardization in assessment protocols. However, consistent signals of negative health effects are emerging in populations residing near odour sources. The paper concludes by emphasizing the urgency of implementing shared guidelines and integrated monitoring strategies, as well as regional regulations, and the need for further longitudinal studies to clarify the causal mechanisms underlying the observed effects.

Keywords: odour emissions, public health, regulations, evolution over time.

1 INTRODUCTION

Over the past two decades, legislation on odour emissions has evolved in response to increasing concern about the impact of unpleasant odours on quality of life and public health, particularly in urban and peri-urban areas.

Emissions of odorous volatile compounds are common to many activities and represent one of the environmental impacts that has drawn the most attention from the scientific community in recent years. Although not all unpleasant odours are linked to toxicological risks, the low tolerance for odour nuisance, which negatively affects the quality of life of exposed individuals, is consistent with the world health organization's definition of health damage.

Odour emission assessment is a strategic component of environmental monitoring, which is why considerable efforts are being made at regional, national, and European levels to regulate such emissions. However, the regulatory framework remains fragmented, with different approaches among Italian regions, at the national level, and across European countries.

Odour is now recognised as an essential environmental parameter in determining quality of life, with significant effects on multiple activities and on citizens' daily lives. For this reason, there is a growing commitment to improving knowledge on this issue to promote methods and tools that enable effective intervention on odour emissions, particularly targeting the sources.

Scientific and technological research can guide or suggest useful methodologies for the chemical characterisation of odours or for identifying emission sources. However, targeted controls are necessary to enable the adoption of measures to contain odour nuisances in order to eliminate, or at least reduce, this discomfort. The development of new technologies can

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allow environmental agencies to intervene more rapidly than in the past when such events occur. Nevertheless, there must also be awareness of the need for adequate legislation that protects individuals who are repeatedly exposed to such odours.

In recent years, the establishment of facilities capable of releasing odorous emissions in urbanised areas has led to the release of unpleasant substances, raising public concern about odour pollution. This pollution is often characterised by its unpredictability, persistence, and the inability to protect oneself from it, generating discomfort, anxiety and protest within the public, partly due to growing attention to environmental and health protection.

In conclusion, this study aims to provide an overview of the evolution of odour emission regulation and the methodologies applied in assessing such emissions, with a focus on population health. An odour is generated by a mixture of more or less volatile and persistent compounds that surround us in everyday life. It is a complex issue that is continuously evolving, both in terms of regulation and in the concrete evaluation of odour nuisances through appropriate instrumentation.

2 REGULATORY FRAMEWORKS

2.1 Definition of odour

According to the UNI 11806:2021 standard [1], the term odour is defined as the sensation perceived by an individual, processed by the olfactory system in response to a stimulus determined by the specific interaction with a mixture of odorous substances.

Characterization methodologies are divided into analytical and sensory. Analytical methods qualitatively and quantitatively measure the composition of a mixture of analytes, while sensory methods use the human nose as a sensor.

In the characterization of odour emissions, the goal is to know the exact composition of the mixture, its concentration, and its relationship with human perception. Gas chromatography–olfactometry is a hybrid analytical technique that combines chemical characterization analytical techniques with sensory techniques.

To overcome elements of subjectivity and achieve method standardization, the European standard EN 13725 of 2003 'Determination of odour concentration by dynamic olfactometry', updated in 2022 as 'Stationary source emissions – determination of odour concentration by dynamic olfactometry and odour emission rate', was introduced. This standard provides the procedures for the olfactometric measurement method, adopted as a common basis for the evaluation of odour emissions by EU member states, and introduces the European odorimetric unit (ou_E/m^3), defined as the quantity of odorant evaporated into 1 m^3 of neutral air under standard conditions [2].

2.2 European regulatory framework

Following Directives 2010/75, 2008/1 and 96/61/EC on integrated pollution prevention and control, and Legislative Decree 46/2015 – Implementation of Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) – as well as Legislative Decree 59/05, the definitions of emission and limit value are provided.

More recently the Directive 2010/75 has been updated to Directive (EU) 2024/1785 of the European Parliament and of the Council of April 24 2024 amending Directive 2010/75/EU of the European Parliament and of the Council concerning industrial emissions (integrated pollution prevention and control), and Directive 1999/31/EC of the Council on Landfills.

2.3 Italian national regulations

At the national level, the 'Directorate Decree approving the guidelines for the application of Article 272-bis of Legislative Decree 152/2006 on odour emissions from plants and activities' was issued, developed by the 'Emissions Coordination' group.

The Decree definitively approves the 'guidelines' for the application of Article 272-bis of Legislative Decree 152/2006 concerning the management of odour emissions from plants and activities, prepared by the 'Emissions Coordination' group established under Article 281, paragraph 9, of Legislative Decree 152/2006 [3]. This provides an important reference framework to be used during technical and decision-making procedures by competent authorities in environmental permitting and for the future development of regional and national regulations. A gradual alignment with European standards began through the adoption of the following UNI standards:

- UNI EN 13725:2022 – 'Determination of odour concentration by dynamic olfactometry';
- UNI 11761:2023 – 'Emissions and air quality – Determination of odours using IOMS (Instrumental Odour Monitoring Systems)';
- UNI EN 16841-1:2017 – 'Ambient air – Determination of odour in ambient air by field inspection – Part 1: Grid method';
- UNI EN 16841-2:2017 – 'Ambient air – Determination of odour in ambient air by field inspection – Part 2: Plume method';
- ISPO 16000-28 – 'Determination of odour emissions from building products using test chambers'.

More recently, with Resolution No. 268/25 of the SNPA Council dated 23.01.2025, the guideline entitled: 'Odour emissions: reference elements and methodological approaches for monitoring' was published [4].

2.4 Italian regional regulations

Across the Italian national territory, ten regions have responded to local demands by developing regulations and guidelines aimed at managing the complexities of these phenomena:

- Veneto: March 10 2000, No. 766 – 'Technical standards and operational guidelines for the construction and operation of facilities for the recovery and treatment of the organic fraction of municipal waste and other organic matrices through composting, biostabilization, and anaerobic digestion';
- Veneto: February 25 2005, No. 568 – 'Amendments and additions to Regional Decree No. 766 of March 10 2000 – Technical standards and operational guidelines for the construction and operation of facilities for the recovery and treatment of the organic fraction of municipal waste and other matrices through composting, biostabilization, and anaerobic digestion';
- Emilia-Romagna: October 24 2011, No. 1495 – 'Technical criteria for mitigating environmental impacts in the design and management of biogas plants';
- Lombardia: April 16 2003, No. 7/12764 – 'Guidelines for the construction and operation of compost production facilities';

- Lombardia: February 15 2012, No. IX/3018 – ‘General provisions regarding the characterization of gas emissions from activities with a high odor impact’;
- Piemonte: January 9 2017, No. 13/4554 (L.R. 43/2000) – ‘Guidelines for the characterization and containment of gaseous emissions from activities with a high odor impact’;
- Provincia Autonoma di Trento: June 24 2016, No. 1087 – ‘Guidelines for the characterization, analysis, and definition of technical and management criteria for mitigating emissions from activities with an odor impact (Art. 102-sexies of the Provincial Consolidated Environmental Protection Act)’;
- Abruzzo: May 26 2004, No. 400 – ‘Regional directives concerning performance and management requirements for urban waste treatment plants, specifically composting facilities’;
- Abruzzo: November 25 2005, No. 1244 – ‘Regional directives concerning performance and management requirements for urban waste treatment plants. Amendments and additions to Regional Decree No. 404/2004’;
- Basilicata: April 22 2002, No. 709 – ‘Guidelines for the design, construction, and management of composting and waste stabilization plants’;
- Basilicata: September 23 2021, No. 39 – ‘Guidelines for the design, construction, and management of composting and biostabilization plants’;
- Puglia: January 22 1999, No. 7 – ‘Regulation of odor emissions from companies. Emissions from olive residue processing plants. Emissions in high environmental crisis risk areas’;
- Puglia: April 16 2015, No. 23 – ‘Amendments to Regional Law No. 7 of January 22, 1999, as amended by Regional Law No. 17 of June 14, 2007 (Art. 4 – atmospheric emissions)’;
- Puglia: July 16 2018, No. 32 – ‘Regulation on odorous emissions’;
- Sicilia: Commissioner’s Ordinance, May 29 2002 – ‘Guidelines for the design, construction, and management of composting facilities’;
- Sicilia: Decree of the Regional Councillor for the Environment No. 154/GAB of September 24 2008 – ‘Approval of guidelines to combat the phenomenon of odorous substance emissions as part of the fight against air pollution’;
- Sicilia: May 16 2012, Decree – ‘Guidelines to combat atmospheric gas emissions from activities with an odor impact as part of the fight against pollution’.

3 HEALTH ISSUES

3.1 Classification of emissions and symptoms

The best approach to the issue of odour nuisances is preventive, through the adoption of structural and operational solutions that reduce the impact of emissions.

The term ‘emission’ is defined as: ‘The direct or indirect release from point or diffuse sources of the plant of substances, vibrations, heat, or noise into the air, water, or soil’.

The limit value must ensure ‘an equivalent level of environmental protection as a whole and must not lead to greater pollutant loads in the environment’. The subjective ability to perceive an odour varies greatly, the same stimulus can elicit different sensations in different people. Individuals may react to odours with varying degrees of sensitivity: low-intensity odour emissions may be perceived only by certain individuals, while conversely, high-intensity odour emissions are noticed by the majority of people, though responses can still be highly variable.

Sensory responses can vary due to physiological factors (e.g., age and sex), social factors, differences in perceived health risk, and habituation in cases of prolonged or repeated exposure. People exposed to the same odour over a long period may no longer perceive it, even if it is unpleasant, creating a kind of tolerance mechanism. An illustration of how odour sense works in humans is shown in Fig. 1. Here, odour molecules are passing through the nasal cavity in our olfactory system. Then, the odorant activates the olfactory receptors. Next, the activated olfactory receptors sent signals related to odorant olfactory epithelium to the olfactory bulb. Then, olfactory bulbs transmit the perceived odorant signal to the brain's higher regions [5].

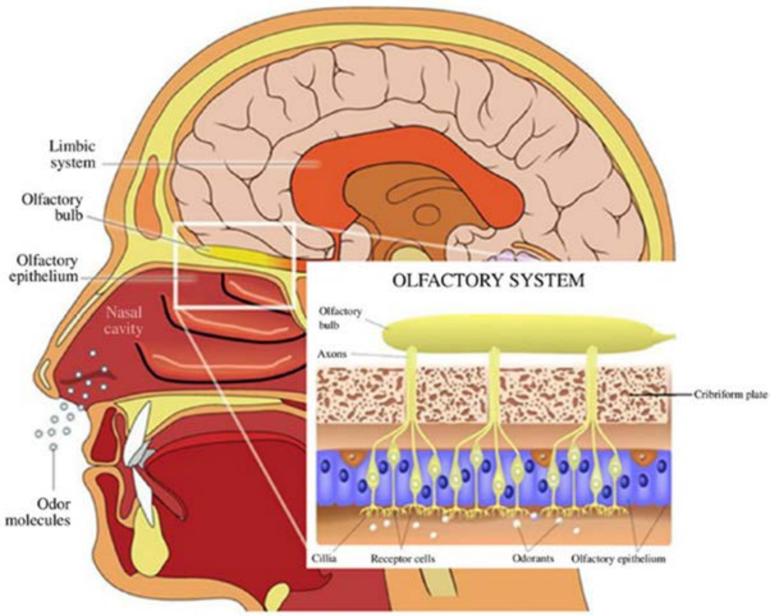

Figure 1: Odour reproduction technology using a small set of odour components [5].

When not directly linked to toxic substances, unpleasant odours are more of a stressor (disturbance, nuisance) than an actual health risk, and potential adverse effects are often associated only with olfactory discomfort. Among the disorders and alterations in general well-being induced by odour perception, the following may occur: eye, nose and throat irritation, headaches, nausea, diarrhoea, hoarseness, sore throat, coughing, chest tightness, nasal congestion, palpitations, shortness of breath, asthma, stress, drowsiness, mental confusion, memory loss, mood disorders, muscle and joint pain, and skin rashes.

Prolonged exposure to an unwanted odour can significantly affect population well-being over multiple organs. This syndrome has no scientific basis; it is a chronic disorder reactive to exposure to chemical substances at levels lower than those generally tolerated by other individuals and in the absence of functional tests capable of explaining signs and symptoms.

The symptomatology, which generally tends to regress following the removal of the implicated chemical agent, includes numerous and nonspecific disturbances affecting multiple organs. The EPA (USA) indicates that about one-third of people working in an indoor occupational environment report a particular sensitivity to one or more common chemical substances. Symptoms resulting from exposure to non-harmful malodours usually disappear quickly when the odours cease.

Aromatic compounds such as benzene, ethylbenzene, or toluene are generally considered highly harmful to health; in particular, benzene is classified as a definite carcinogen (group 1) by the IARC (Fig. 2), especially for blood cancers.

Group	*Name*	n. agents May	n. agents July	n. agents July II	n. agents Sept.	n. agents Jan.	n. agents June	n. agents April
Group 1	*Carcinogenic to humans*	121	126	126	127	128	129	133
Group 2A	*Probably carcinogenic to humans*	90	94	95	95	95	96	96
Group 2B	*Possibly carcinogenic to humans*	323	322	323	323	323	321	322
Group 3	*Not classifiable as to its carcinogenicity to humans*	498	500	500	500	500	499	501

Figure 2: List of classifications by cancer site [6].

There are at least three mechanisms through which miasmas can produce health symptoms:

1. Symptoms may be induced by exposure to odorous substances present at concentrations high enough to cause irritation or other toxicological effects. In this case, it is irritation rather than the odour itself that causes the perceived symptoms, and the odour (the sensation) simply serves as an indicator of exposure.
2. Symptoms caused by odorous compounds present at low, non-irritating concentrations may be due to pre-existing conditions, either innate (genetically encoded) or learned.
3. Symptoms may be caused by a co-pollutant (such as an endotoxin) that is part of an odorous mixture. However, objective biomarkers of symptoms caused by odorants are needed to determine the actual health effects.

Other aspects to consider include:

- Frequency**:** how often an individual is exposed to the odour;
- Intensity**:** the strength of the sensation generated by an odour;
- Duration**:** the length of time an individual is exposed to an odour;
- Offensiveness**:** the nature of the odour in terms of its hedonic tone, referring to how unpleasant or pleasant an odour is perceived;
- Localization**:** land use and the nature of human activities near the odorous source.

Prolonged exposure to high concentrations can gradually lead the sense of smell to adapt. In general, adaptation refers to the process by which small environmental changes cause unconscious modifications in individual behaviour, leading people to adjust to the new conditions. Specifically, in the case of smell, adaptation to a certain odour means the loss of sensitivity to that particular stimulus, tolerance, with the possibility that, gradually, the ability to perceive that odour decreases and eventually disappears all together.

3.2 Substances that generate nuisances at low concentrations

Malodorous and genuinely hazardous substances that cause irritation even at low concentrations include:

- Hydrogen sulphides: truly poisonous substances. Prolonged exposure to high concentrations can be fatal. In nature, hydrogen sulphide forms through the decomposition of sulphur-containing proteins by bacteria; it is therefore found in swamp gases, crude oil, and natural gas. At low concentrations, hydrogen sulphide gradually causes eye irritation, upper respiratory tract irritation, and pulmonary oedema. At higher concentrations, near lethal limits (>700 ppm), it produces an almost pleasant smell, or is not detected at all, because it destroys the olfactory cells.
- Mercaptans: organic compounds known for their intensely unpleasant odour. They are widely used in the odorization process, an industrial practice of adding strongly smelling substances to otherwise odourless or nearly odourless ones to make their presence detectable. For example, they are added to methane, which is odourless and colourless, to make gas leaks perceivable. Mercaptans can cause gastric effects, impair oxygen transport, and, like hydrogen sulphide, provoke severe respiratory system irritation even with short-term exposure.
- Carbon disulfide: a poorly water-soluble sulphur compound abundant in the atmosphere. It has both natural origins (emitted by oceans, volcanoes, and hydrothermal sources) and anthropogenic ones (released by cars, coal-fired power plants, biomass/plastic waste combustion, fish processing, petroleum industries, and synthetic fibre, starch, and rubber production). It has an unpleasant odour. At low concentrations, it irritates the skin, eyes, nose, and airways; at higher concentrations, it affects the nervous system, causing loss of consciousness and potentially death. Chronic exposure to low concentrations can cause heart attacks and increased blood pressure.
- Ammonia: a colourless, toxic, water-soluble gas with a characteristic pungent odour. Like hydrogen sulphide, ammonia is also produced in landfills. It has countless uses: it is extremely important in industrial settings and is used in many applications, such as in household cleaners, as a base for agricultural fertilizers, in paint manufacturing, and more. Ammonia is strongly irritating to the airways, and prolonged exposure to low concentrations can lead to chronic bronchitis.
- Ketones: organic compounds that appear as colourless, volatile substances with a sharp, characteristic odour. At moderate concentrations, they may cause irritation, especially to the eyes and nasal mucosa, with potential corneal damage and even permanent vision impairment. At higher concentrations, they can have narcotic effects, damaging the central and peripheral nervous systems.
- Aldehydes: often considered ‘synthetic’ compounds, but in reality, they are naturally present as they are produced during sugar fermentation processes. Aldehyde odours range from unpleasant (e.g., formaldehyde, once used as a disinfectant in hospitals) to less disturbing. Aldehydes irritate the eyes and respiratory tract mucosa. Unsaturated aldehydes or those with halogen substituents can cause serious damage to the respiratory system.
- Organic acids: the extent and severity of effects depend on the acid’s strength, concentration, exposure duration and conditions, and inherent toxicity. At low concentrations, they generally don’t cause severe effects, excluding chronic bronchial irritation. However, vapor toxicity increases with halogenation. In some cases, such as

chloroacetic acid, trichloroacetic acid, or trifluoroacetic acid, their caustic effects cause serious burns to the skin, eyes, and airways.

- Aromatic hydrocarbons: ‘hydrocarbons’ is a general term for all organic compounds made up only of carbon and hydrogen. The term ‘aromatic’ comes from the fact that the first compounds discovered in this class had intense, characteristic odours. Today, aromatic compounds are defined as all organic compounds containing one or more aromatic rings in their structure. This group includes a vast number of compounds (benzene, ethylbenzene, toluene, etc.), all with well-documented toxicity. Benzene is classified by IARC as Group 1 (sufficient evidence of carcinogenicity in humans). IARC has also classified benzo[a]pyrene and other PAHs with 4–6 fused rings into Group 2A or 2B, meaning they are ‘probable or possible human carcinogens’ (Fig. 2) [6].

The main consequences of exposure to odour pollution are therefore:

- a significant reduction in the enjoyment of the environment;
- the production of stress;
- a deterioration of physical, mental, and social well-being;
- the generation of health risks.

4 MONITORING AND ASSESSMENT TECHNIQUES

4.1 Italian regulatory framework

By analysing instrumental systems for continuous odour monitoring, it becomes evident that the olfactory impact on the receptor is assessed by determining the following factors:

- Frequency (how often an individual is exposed to the odour),
- Intensity (individual perception of the odour’s strength),
- Duration (total length of an odour episode, i.e., how long the concentration remains above the threshold),
- Offensiveness (hedonic tone: pleasant, neutral, or unpleasant),
- Localization (receptor characteristics, sensitivity, and socio-economic factors).

Frequency and duration represent the temporal dimension of the olfactory phenomenon and are associated with the organism’s adaptation to environmental stimuli.

From the assessment of the odour phenomenon, it is evident that there is temporal and spatial variability in the presence of odorants in the air, and to date, no standardized method has been established for long-term monitoring of such highly variable phenomena. In particular:

- For intensity, the relevant standard is UNI EN 13725:2022 [7] on emissions from stationary sources, which determines odour concentration through dynamic olfactometry and odour emission rate.
- For spatial dispersion, the reference is UNI EN 16841-1:2017 [8], and UNI EN 16841-2:2017 [9], which address ambient air – determination of odour in ambient air by field inspection.

Monitoring the temporal variability of the presence of odorants in the air currently lacks an international technical standard. Therefore, there is a need to acquire instrumental signals that can be associated with the presence of odorant mixtures in the air at high frequency. These instrumental systems can provide continuous monitoring, which is very useful for identifying critical events (such as uncontrolled releases) and for validating computational models (tools that allow us to detect the presence of individual analytes).

Continuous monitoring systems also allow us to determine the concentration of odorants, the sensitivity threshold, and the duration of threshold exceedance. With hourly data, we can correlate this information with wind data.

For the identification of odorants, the Italian national standard UNI EN 11761:2023 'Emissions and air quality – Determination of odours using IOMS (Instrumental Odour Monitoring Systems)' defines an automatic odour measurement system as one that can periodically provide information on the odour of a gas mixture, using reference data obtained from sensory odour measurements (via a panel of assessors) (Figs 3 and 4) [10]. These systems are often referred to as 'electronic noses', due to their analogy with human physiology, which leads to olfactory perception.

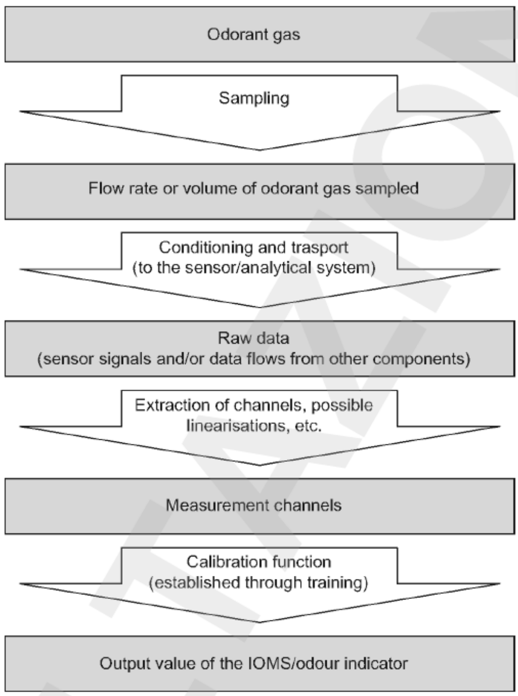

Figure 3: Flowchart of the measurement [10].

4.1 The so-called electronic nose

In human physiology, we have 400 receptors that send signals integrated into the olfactory bulb and recognized in the frontal cortex. Similarly, in electronic noses, we have a limited number of sensor systems, whose signals are stored in a database and compared to reference values using processing algorithms. While effective, these systems remain rudimentary when compared to human physiological complexity. We use aspiration systems to feed the sensors.

Type of measurement	Reference method
Type A measurement (presence/absence of odour)	Sensory method, using a panel made up of at least 1 examiner, whose individual olfactory sensitivity to the reference odorant shall meet the requirements specified in UNI EN 13725.
Type B measurement (odour class)	Each odorous emission (source) included in the examination is associated with 1 odour class. The odour class corresponding to the emission from which the sample used for the dilutions was taken is assigned to the samples obtained by dilution.
Type C measurement (odour quantity)	UNI EN 13725

Figure 4: Reference methods in the IOMS output verification process [10].

The air samples collected contain many molecules with very low olfactory thresholds and thus can be perceived at very low concentrations – others act as interferents.

The sensor technologies currently available are increasingly diverse. The most common include:

- MOS (metal oxide sensor),
- Nanocomposite polymers,
- PID (photoionization detector),
- MOSFET (metal-oxide-semiconductor field effect transistor),
- QCM (quartz crystal microbalance),
- SAW (surface acoustic wave),
- SPR (surface plasmon resonance),
- CP (intrinsically and doped conductive polymers).

A sensor generally recognizes a chemical class of odorants, not individual types of substances, e.g., hydrocarbons, amines, sulphur compounds, aldehydes, and organic acids, etc.

Correct positioning of the electronic nose is fundamental; the best instrument, if not properly positioned, does not provide useful information for management.

Positioning should be carried out in sensitive locations based on reports from citizens (which are to be objectively verified), sensitive receptors (schools, hospitals, etc.), and areas with the highest odour impact (identified using numerical models).

The advantages of electronic noses include recording signals at a high temporal frequency (minutes, seconds), long-term monitoring (months), the possibility of correlation with high-frequency meteorological data (temperature, humidity, wind), and the ability to validate citizens' reports.

The disadvantages are the difficulty in correlating with official odour measurement units (odour units, UoE) and potential malfunction under particular conditions of temperature, humidity, or presence of airborne dust.

4.2 Web apps

With the introduction of web apps, the aim is to engage the public and involve them in monitoring various issues. They provide a large amount of data on a wide spatial and temporal scale, as well as useful information for research.

Volunteer citizens are trained regarding the subject of study and informed about the ways in which the collected data will be used and the potential effects the obtained results may have on research and policy decisions.

The first approach to the odour monitoring process involved drafting paper questionnaires. With the advent of smartphones and Apps, it became possible to improve, optimize, and speed up the collection of such information, which today is also georeferenced in real time.

The use of digital technology has increased the potential of the phenomenon, becoming a tool for the development of technology serving scientific research, particularly in the environmental field. The transition from paper to App was preceded by an odour nuisance detection system that allowed reporting the odour disturbance through a phone call made from a landline to a call centre. A precursor was the Odortel project by ARPA Puglia (telephone reports).

Two examples of web apps are the NOSE project by ARPA Sicily [11] and the OdorNet project by ARPA Marche [12]. Web apps allow real-time data acquisition from the population and promote collaboration between citizens and institutions.

The need to investigate the phenomenon led to the implementation of the detection system through web-based systems with online questionnaires, as in the case of ARPA (Regional Agency for Environmental Protection) Puglia and ARPA Sicily. Web apps and associated web platforms can provide multiple user profiles with differentiated access: citizens can submit reports and view maps and reports in addition to specific project information; authorized ARPA technicians can receive notifications of all submitted reports, view analyses, and download data.

The minimum dataset to be provided concerns the intensity of the perceived odour (weak, strong, very strong), the type of odour (hydrocarbons, solvents, sewage, burnt, waste, other), date and time of the nuisance, georeferenced location, and weather-climatic conditions.

Additional information that citizens may add includes any symptoms experienced at the time of the perceived odour nuisance and the completion of a general notes field where citizens can communicate details about the disturbance or express opinions. The collected data are then processed, and the first data handling step involves validating the reports.

In the second phase, the geolocation of the reports is evaluated, for example, whether they are concentrated in an area, near a facility, etc.

Besides real-time investigation, the various data in the databases can be analysed to determine, within a defined time period, the odour mostly perceived during the reports, the intensity of reported nuisances, and correlations with atmospheric data.

Source identification can be enhanced through environmental modelling.

The above was also analysed in the article ‘Automated collection of real time alerts of citizens as a useful tool to continuously monitor malodorous emissions’ [13], which related citizen-received odour nuisance reports with readings from ARPA monitoring stations continuously measuring some compounds directly related to odorous emissions.

5 CONCLUSIONS

Odorous emissions represent a form of environmental pollution that is often overlooked yet it has significant impacts on the quality of life and psychophysical well-being of exposed populations, particularly in urban and peri-urban settings. Despite increasing scientific and institutional attention to the issue, available knowledge on the short- and long-term effects of exposure to nuisance odours remain partial and fragmented.

Although still limited compared to other forms of pollution, scientific evidence suggests a correlation between exposure to unpleasant odours and a range of health disturbances, including stress, respiratory symptoms, headaches, sleep disorders, and an overall decline in quality of life. The complexity of assessing the health impact of odours stems both from the subjectivity of olfactory perception and from the difficulty of measuring and characterizing odorant mixtures. This hinders the integration of odours into traditional models of environmental and health risk assessment.

The highly subjective nature of odour perception and the chemical complexity of odorant mixtures make it difficult to standardize measurements and define universally accepted exposure thresholds. However, advances in analytical, sensorial, and participatory methodologies, such as the use of sensors and citizen involvement through apps and monitoring networks, offer new opportunities for more effective management of the issue.

It is necessary to promote a more coherent and harmonized regulatory framework at both national and European levels, one that recognizes the impact of odorous emissions as a genuine public health concern. At the same time, the integration of targeted epidemiological studies is desirable to systematically assess exposure and health effects, in order to inform prevention, mitigation, and spatial planning strategies that are more sensitive to the well-being of affected communities.

In light of these challenges, it is a priority to develop new interdisciplinary research approaches that integrate chemical, toxicological, epidemiological, and socio-psychological expertise. Promoting longitudinal studies capable of linking odour exposure to health impact markers, also through the use of innovative technologies (e.g., smart sensors, citizen science, predictive models) and participatory methods, will be essential.

Only by strengthening the scientific foundation will it be possible to address the issue of odorous emissions more effectively, ensuring better protection of public health and the quality of life of exposed populations.

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